[10191/2054]

DEVICE FOR MEASURING AT LEAST ONE PARAMETER OF A FLOWING MEDIUM

FIELD OF THE INVENTION

The present invention relates to a device for measuring at least one parameter of a medium flowing in a line.

BACKGROUND INFORMATION

German Published Patent Application No. 196 52 153 describes a device having a measuring element for measuring a mass of a flowing medium, in which a flow straightener with a screen is provided upstream from the measuring element. The flow straightener with screen is installed in a rigid conduit inside the line, thereby constricting the line.

German Published Patent Application No. 197 38 337 and U.S. Patent No. 5,892,146 respectively describe a hot-wire air-flow meter, having an orifice that forms a single unit with one wall of the line and is located upstream from the measuring element. This arrangement constricts the line and increases the flow velocity of a forward mass flow with pulsating flow downstream from, and within the diameter of, the orifice without destroying the flow.

Ring-shaped constrictions in devices, such as those described above may, under certain flow conditions, produce acoustic disturbances in the line that become noticeable in the form of whistling sounds.

These disturbances are triggered by ring-shaped eddies arising downstream behind one edge of the constriction and propagate in the direction of flow of the line.

German Published Patent Application No. 198 156 58 describes a device having a measuring element to measure a mass of a medium flowing in a line, with a flow pipe being located in the line and the measuring element being provided in the flow pipe. Any loud, disturbing whistling noises that occur are reduced by structural grooves in the end face of the flow pipe.

SUMMARY

The device according to the present invention has the advantage that acoustic disturbances are avoided. This result is achieved in that suppression elements are used to reduce the formation of ring-shaped eddies.

At least one prevention element may be integrated into a rigid conduit of a flow straightener or into a second rigid conduit to simplify manufacturing.

If there is no flow straightener or rigid conduit, integrating at least one prevention element into one wall of a line may simplify manufacturing.

According to one arrangement of the suppression elements, the latter may be evenly distributed in the circumferential direction of the line and have the same shape to avoid distorting the velocity profile of the flow.

At least one suppression element may be configured as an elevation in the line to simplify manufacturing.

One example embodiment of the suppression element provides an orifice with different sections, the radial spacing of which varies in relation to a center line of the line.

The prevention elements may be rounded against the main direction of flow to avoid distorting the velocity profile of the flow.

A tubular body may be provided in the line, thereby avoiding a deviation in the measurement characteristic of a measuring element, caused by the impact of fluid or solid particles.

A protective screen may be integrated into the line or into the tubular body.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of a device according to the present invention having a flow straightener and a screen, in which at least one prevention element according to the present invention is provided.

Figures 2a and 2b illustrate a section of the device illustrated in Figure 1.

Figures 3a to 3d illustrate several example embodiments of suppression elements.

Figure 4 is a perspective view of a device according to the present invention with a tubular body.

DETAILED DESCRIPTION

Figure 1 is a partial cross-sectional view of a device 1 for measuring at least one parameter of a medium flowing in a line 14, in particular a parameter of the intake air mass of an internal combustion engine. Parameters of a flowing medium are, for example, volumetric flow for determining a mass, a temperature, a pressure or a flow velocity, which are detected

which measuring element 25 is provided for measuring the medium flowing in instrument gland 7, is incorporated into measuring unit 4 of device 1. The structure of a measuring unit 4 of this type, having a measuring element 25, is described, for example, in German Published Patent Application No. 44 07 209.

A screen 32 and a sleeve-like flow straightener 30, which is attached, for example, to a rigid conduit 33, are provided upstream from measuring element 25. Rigid conduit 33 includes an inner diameter that is smaller than line 14, thus forming a constriction 35.

Flow straightener 30 is made, for example, of plastic and is produced, for example, by injection molding and includes a multiplicity of, for example, rectangular openings 34 oriented in the direction of flow.

The structure of a flow straightener 30 of this type, having screen 32, is described, for example, in German Published Patent Application No. 196 52 753. At least one acoustic prevention element 40 is integrally attached, for example, to rigid conduit 33 of flow straightener 30.

For the purpose of final assembly of device 1, the assembly unit formed by flow straightener 30 and screen 32 is inserted into a, for example, circular opening 47 provided at the upstream end of instrument gland 7, until ring-shaped wall 50 of flow straightener 30 comes into contact with a stop 52 of instrument gland 7 that reduces the cross-section of opening 47.

To permanently hold flow straightener 30 in place in opening 47, flow straightener 30 includes barbed hook elements 57 on rigid conduit 33, which, for example, extend slightly outward radially from its external surface 55 and may correspondingly latch into place in a groove 60 provided in an inner wall of opening 47 in instrument gland 7.

Figure 2a illustrates an enlarged portion of Figure 1, identified by a dotted line. Locking hooks 63 are elastic and have locking heads 65 that extend inwardly in a radial direction. When screen 32 is installed, locking heads 65 grip around an edge of screen 32 like pliers and rest against a surface 68 of screen 32 facing measuring unit 4, so that locking heads 65 press screen 32 against a circumferential shoulder 74 of flow straightener 30 formed by inner surface 70.

A second rigid conduit 72 is located downstream behind rigid conduit 33. Second rigid conduit 72 is provided at the same radial distance from center line 21 as inner surface 70. At the downstream end of second rigid conduit 72 is provided at least one acoustic prevention element 40, which, for example, forms a single unit and extends into line 14 in a radial direction. Second rigid conduit 72 is pressed against shoulder 52, for example, by rigid conduit 33. However, it may also be fastened in line 14, like rigid conduit 33. Acoustic suppression element 40 acts mechanically on the flow in line 14, thus preventing ring-shaped eddies that form downstream behind an edge of a constriction and propagate in the direction of flow of the line, becoming noticeable in the form of whistling noises.

In a cross-sectional view along main direction of flow 18 through prevention element 40, prevention element 40 includes, for example, a rounded shape 41 in the upstream direction and a rough edge 42 in the downstream direction. The at least one suppression element 40 constricts line 14 by 2% to 30%.

Figure 2b illustrates the arrangement of second rigid conduit 72 and rigid conduit 33 as a single unit. Viewed in the downstream direction, rigid conduit 33 includes an extension arm 77 that continues behind screen 32 along inner wall 15. Acoustic prevention element 40, which extends into line 14 in a radial direction, is located at end 78 of extension arm 77. Screen 32 is installed, for example, by bending rigid conduit 33 outwardly radially in the region of extension arm 77 and then inserting screen 32.

Figures 3a to 3d illustrate several example embodiments of prevention element 40. The same reference numbers used in the previous figures identify the same or functionally equivalent components.

Figure 3a illustrates a prevention element 40 that is configured as a radial elevation 79 relative to center line 21 and includes a rectangular cross-section at right angles to main direction of flow 18. Elevations 79, for example, are of the same size and are evenly distributed along a circumferential line 80 of line 14, which is indicated by the dotted line.

Radial elevations 79 illustrated in Figure 3b have a semicircular cross-section at right angles to main direction of flow 18. Figure 3c illustrates that radial elevations 79 may have different geometries in one embodiment of the device.

In the radial cross-section, they are, for example, trapezoidal or semicircular. Elevations 70 are distributed evenly and arranged symmetrically.

Figure 3d illustrates a prevention element 40 configured as an orifice 82, the radial limiting line 81 of which does not have a constant inner diameter and is configured, for example, in the shape of a wave.

Prevention elements 40 in this case form, for example, a single unit with instrument gland 7.

Figure 4 illustrates device 1 in a line 14 within which a medium flows. The same reference numbers used in the previous figures identify the same or functionally equivalent components. In line 14, and spaced at a radial distance from line 14, is provided, for example, a tubular body 85, around which the medium flows and which serves as an element 84 for reducing the impact of fluid or solid particles on measuring element 25.

Prevention elements 40 are arranged in main direction of flow 18 so that their rough edges 42 are located after or at the same level as a tubular inlet opening 88 in tubular body 85 when viewed in the axial direction.

Prevention elements 40 in this case are connected to instrument gland 7, for example, forming a single unit. However, they may also be provided as additional units or only on tubular body 85.

Prevention elements 40 may, for example, also be provided in tubular body 85.

The at least one prevention element 40, 79, 82 is connected, for example, to tubular body 85, for example, forming a single unit. Tubular body 85 includes a flow channel 87 and a protective screen 90, located in the region of its upstream end, as an element 84 for reducing the impact of fluid or solid particles on measuring element 25.

Protective screen 90 may be configured, for example, as a wire mesh or plate-type screen. Any other shape is also possible. Plastic, metal, ceramic or glass may be used as the material for protective screen 90, in the case of both the wire mesh and plate-type protective screen 90. Plate-type protective screen 90 made of plastic may be produced, for example, entirely by injection molding or by creating screen openings 94 in a plate-type basic body using a material-removal method. Plate-type protective screen 90 made of metal may be produced, for example, from a sheet by punching, eroding, drilling, etc.

A direction of flow 98 exists at a slight distance from protective screen 90 in the downstream region of flow channel 87. Direction of flow 98 extends roughly parallel to main direction of flow 18. Line 14 has a center line 21, which, for example, is also the center line of tubular body 85. Measuring unit 4, for example, extends into tubular body 85. A connector end of measuring unit 4 that contains the electrical connections, for example in the form of connector prongs, remains, for example, outside line 14. Measuring element 25, which is in contact with the air flowing through flow channel 87 and is used for detecting air mass entering the internal combustion engine, is provided in a conventional manner in measuring unit 4. Measuring element 25 may be configured in a conventional manner, for example, in the form of at least one temperature-dependent resistor. In particular, it is possible

to configure measuring element 25 as a micromechanical component that has a dielectric diaphragm on which resistor elements are provided, as described, for example, in German Published Patent Application No. 43 38 891 and U.S. Patent No. 5,452,610, respectively. It is also conceivable to incorporate measuring element 25 into line 14 or tubular body 85 without a measuring unit.

At least two braces 101, which hold tubular body 85 in place in line 14, are provided, for example, on tubular body 85. In addition to holding tubular body 85 in place, braces 101 also increase the pressure drop in the air flow between line 14 and tubular body 85, thus increasing the amount of air flowing through flow channel 87, and braces 101 also straighten the intake air flow in the desired manner.

Tubular body 85 may also be provided in line 14 without braces 101, for example, it may be fastened to measuring unit 4.

Protective screen 90 includes, for example, bars 105 that are positioned perpendicular to each other, for example perpendicular to plug-in axis 10 and horizontal to plug-in axis 10, with bars 105 positioned horizontally relative to center line 21, for example, being arranged at an angle of approximately 30 degrees relative to plug-in axis 10. This varies main direction of flow 18 downstream behind protective screen 90. Protective screen 90 may also be oriented at an angle in relation to main direction of flow 18. Dirt particles and fluid droplets are deposited on protective screen 90 and are directed to an inner wall 107 of line 14 or of tubular body 85, thus moving past inlet opening 110 of measuring unit 4 or past measuring element 25.

ABSTRACT

A device for measuring at least one parameter, in particular of a volumetric flow, of a medium flowing in a line, in particular of the intake air volumetric flow of an internal combustion engine, includes at least one measuring element around which the medium flows. Constrictions, which do not uniformly constrict the cross-section of the line, do not produce any ring-shaped eddies that may be heard in the form of whistling noises.

DEVICE FOR MEASURING AT LEAST ONE PARAMETER OF A FLOWING MEDIUM

[Background Information

] **FIELD OF THE INVENTION**

The present invention relates to a device for measuring at least one parameter of a medium flowing in a line [according to the definition of the species in Claim 1].

BACKGROUND INFORMATION

[A] **German Published Patent Application No. 196 52 153 describes a** device having a measuring element for measuring a mass of a flowing medium, in which a flow straightener with a screen is provided upstream from the measuring element[, is known from German Patent Application 196 52 753 A1]. The flow straightener with screen is installed in a rigid conduit inside the line, thereby constricting the line.

[A] **German Published Patent Application No. 197 38 337 and U.S. Patent No. 5,892,146 respectively describe a** hot-wire air-flow meter, having an orifice that forms a single unit with one wall of the line and is located upstream from the measuring element[, is known from German Patent Application 197 38 337 A1 and U.S. Patent No. 5,892,146, respectively]. This arrangement constricts the line and increases the flow velocity of a forward mass flow with pulsating flow downstream from, and within the diameter of, the orifice without destroying the flow.

[Such ring-shaped] **Ring-shaped** constrictions in devices [of the publications mentioned]**, such as those described** above

[can] **may**, under certain flow conditions, produce acoustic disturbances in the line that become noticeable in the form of whistling sounds.

These disturbances are triggered by ring-shaped eddies arising downstream behind one edge of the constriction and propagate in the direction of flow of the line.

[A] **German Published Patent Application No. 198 156 58 describes a** device having a measuring element to measure a mass of a medium flowing in a line, with a flow pipe being located in the line and the measuring element being provided in the flow pipe[, is known from German Patent Application 198 156 58 A1]. Any loud, disturbing whistling noises that occur are reduced by structural grooves in the end face of the flow pipe.

[Advantages of the Invention

] **SUMMARY**

The device according to the present invention[, having the characterizing feature of Claim 1,] has the advantage [over the related art] that [it easily avoids] acoustic disturbances[, since] **are avoided. This result is achieved in that** suppression elements are used to reduce the formation of ring-shaped eddies.

[The measures described in the dependent claims provide advantageous embodiments and refinements of the device mentioned in Claim 1.]

At least one prevention element [is advantageously] **may be** integrated into a rigid conduit of a flow straightener or into a second rigid conduit to simplify manufacturing.

If there is no flow straightener or rigid conduit, integrating at least one prevention element into one wall of a line [advantageously simplifies] **may simplify** manufacturing.

According to one [advantageous] arrangement of the suppression elements, the latter [are] **may be** evenly distributed in the circumferential direction of the line and have the same shape to avoid distorting the velocity profile of the flow.

At least one suppression element [is advantageously designed] **may be configured** as an elevation in the line to simplify manufacturing.

One [advantageous] **example** embodiment of the suppression element provides an orifice with different sections, [whose] **the** radial spacing **of which** varies in relation to a center line of the line.

The prevention elements [are advantageously] **may be** rounded against the main direction of flow to avoid distorting the velocity profile of the flow.

[It is particularly advantageous to use a] **A** tubular body **may be provided** in the line, thereby avoiding a deviation in the measurement characteristic of a measuring element, caused by the impact of fluid or solid particles.

[It is also advantageous to integrate a] **A** protective screen **may be integrated** into the line or into the tubular body.

[Drawing] **BRIEF DESCRIPTION OF THE DRAWINGS**

[Exemplary embodiments of the present invention are illustrated in simplified form in the drawing and explained in greater detail in the description below.]

Figure 1 [shows] **is a schematic view of** a device according to the present invention having a flow straightener and a screen, in which at least one prevention element according to the present invention is provided[;]**.**

Figures 2a[,] **and** 2b [show an extract of] **illustrate a section of the device illustrated in** Figure 1[;]**.**

Figures 3a [through] **to** 3d [show multiple] **illustrate several example** embodiments of suppression elements[; and]**.**

Figure 4 [shows] **is a perspective view of** a device according to the present invention with a tubular body.

[Description of the Embodiments] **DETAILED DESCRIPTION**

Figure 1 [shows] **is** a [partially cut-away] **partial cross-sectional** view of a device 1 for measuring at least one parameter of a medium flowing in a line 14, in particular a parameter of the intake air mass of an internal combustion engine. Parameters of a flowing medium are, for example, volumetric flow for determining a mass, a temperature, a pressure or a flow velocity, which are detected using suitable

sensors. Device 1 [can] **may** also be used to measure additional parameters.

The flowing medium [can] **may** be air, a gas mixture or a fluid. The internal combustion engine [can] **may** be, for example, a mixture-compressing engine with externally-supplied ignition or even an air-compressing engine with spontaneous ignition.

Device 1 includes at least one measuring unit 4, which, for example, [can] **may** be plugged into an instrument gland 7 of device 1, and in which is provided a measuring element 25. Measuring element 25 [can] **may** be, for example, a temperature sensor ([like the one known from] **such as that described in** German **Published** Patent Application **No.** 42 28 484 [A1]), a pressure sensor ([like the one known from] **such as that described in** German **Published** Patent Application **No.** 34 35 794 [A1]), or an air-flow sensor, which detects the corresponding parameters. [By way of] **For** example, a volumetric air-flow sensor is selected as one of the different possible sensors.

Measuring unit 4 [has] **includes**, for example, a narrow, rod-like, cuboid shape that extends longitudinally in the direction of a plug-in axis 10 and [can] **may** be introduced, for example, by plugging, into an opening provided in one wall 13 of instrument gland 7. Wall 13 [has] **includes** an inner wall 15 and limits a flow cross-section of line 14, which [has] **includes**, for example, a circular cross-section, in the center of which a center axis 21 extends parallel to wall 13 in direction 18 of the flowing medium and is oriented perpendicular to plug-in axis 10. In Figure 1, the direction

of the flowing medium is illustrated by arrows 18 and it moves from left to right.

Measuring element 25 is inserted into the flowing medium together with measuring unit 4. A measuring channel 27, in which measuring element 25 is provided for measuring the medium flowing in instrument gland 7, is incorporated into measuring unit 4 of device 1. The structure of a measuring unit 4 of this type, having a measuring element 25, is [sufficiently well known to those skilled in the art, for example, from Unexamined German] **described, for example, in German Published** Patent Application **No.** 44 07 209[, the description of which forms part of the present patent application].

A screen 32 and a sleeve-like flow straightener 30, which is attached, for example, to a rigid conduit 33, are provided upstream from measuring element 25. Rigid conduit 33 [has] **includes** an inner diameter that is smaller than line 14, thus forming a constriction 35.

Flow straightener 30 is made, for example, of plastic and is produced, for example, by injection molding and [has] **includes** a multiplicity of, for example, rectangular openings 34 oriented in the direction of flow.

The structure of a flow straightener 30 of this type, having screen 32, is [sufficiently well known to those skilled in the art] **described**, for example, [from] **in** German **Published** Patent Application **No.** 196 52 753 [A1, the description of which forms part of the present patent application]. At least one acoustic

prevention element 40 is integrally attached, for example, to rigid conduit 33 of flow straightener 30.

For the purpose of final assembly of device 1, the assembly unit formed by flow straightener 30 and screen 32 is inserted into a, for example, circular opening 47 provided at the upstream end of instrument gland 7, until ring-shaped wall 50 of flow straightener 30 comes into contact with a stop 52 of instrument gland 7 that reduces the cross-section of opening 47.

To permanently hold flow straightener 30 in place in opening 47, flow straightener 30 [has] **includes** barbed hook elements 57 on rigid conduit 33, which, for example, extend slightly outward radially from its external surface 55 and [can] **may** correspondingly latch into place in a groove 60 provided in an inner wall of opening 47 in instrument gland 7.

Figure 2a [shows] **illustrates** an enlarged [extract from] **portion of** Figure 1, identified by a dotted line. Locking hooks 63 are elastic and have locking heads 65 that extend [inward] **inwardly** in a radial direction. When screen 32 is installed, locking heads 65 grip around an edge of screen 32 like pliers and rest against a surface 68 of screen 32 facing measuring unit 4, so that locking heads 65 press screen 32 against a circumferential shoulder 74 of flow straightener 30 formed by inner surface 70.

A second rigid conduit 72 is located downstream behind rigid conduit 33. Second rigid conduit 72 is provided at the same radial distance from center line 21 as inner surface 70. At the downstream end of second rigid conduit 72 is provided at

least one acoustic prevention element 40, which, for example, forms a single unit and extends into line 14 in a radial direction. Second rigid conduit 72 is pressed against shoulder 52, for example, by rigid conduit 33. However, it [can] **may** also be fastened in line 14, like rigid conduit 33. Acoustic suppression element 40 acts mechanically on the flow in line 14, thus preventing ring-shaped eddies that form downstream behind an edge of a constriction and propagate in the direction of flow of the line, becoming noticeable in the form of whistling noises.

In a cross-sectional view along main direction of flow 18 through prevention element 40, prevention element 40 [has] **includes**, for example, a rounded shape 41 in the upstream direction and a rough edge 42 in the downstream direction. The at least one suppression element 40 constricts line 14 by 2% to 30%.

Figure 2b [shows] **illustrates** the [design] **arrangement** of second rigid conduit 72 and rigid conduit 33 as a single unit. Viewed in the downstream direction, rigid conduit 33 [has] **includes** an extension arm 77 that continues behind screen 32 along inner wall 15. Acoustic prevention element 40, which extends into line 14 in a radial direction, is located at end 78 of extension arm 77. Screen 32 is installed, for example, by bending rigid conduit 33 [outward] **outwardly** radially in the region of extension arm 77 and then inserting screen 32.

Figures 3a [through] **to** 3d [show different] **illustrate several example** embodiments of prevention element 40. The same reference numbers used in the previous figures identify the same or functionally equivalent components.

Figure 3a [shows] **illustrates** a prevention element 40 that is [designed] **configured** as a radial elevation 79 relative to center line 21 and [has] **includes** a rectangular cross-section at right angles to main direction of flow 18. Elevations 79, for example, are of the same size and are evenly distributed along a circumferential line 80 of line 14, which is [shown] **indicated** by the dotted line.

Radial elevations 79 **illustrated** in Figure 3b have a semicircular cross-section at right angles to main direction of flow 18. Figure 3c [shows] **illustrates** that radial elevations 79 [can] **may** have different geometries in one embodiment of the device. In the radial cross-section, they are, for example, trapezoidal or semicircular. Elevations 70 are distributed evenly and arranged symmetrically.

Figure 3d [shows] **illustrates** a prevention element 40 [designed] **configured** as an orifice 82, [whose] **the** radial limiting line 81 **of which** does not have a constant inner diameter and is [designed] **configured**, for example, in the shape of a wave.

[prevention] **Prevention** elements 40 in this case form, for example, a single unit with instrument gland 7.

Figure 4 [shows] **illustrates** device 1 in a line 14 within which a medium flows. The same reference numbers used in the previous figures identify the same or functionally equivalent components. In line 14, and spaced at a radial distance from line 14, is provided, for example, a tubular body 85, around which the medium flows and which serves as an element 84 for

reducing the impact of fluid or solid particles on measuring element 25.

Prevention elements 40 are arranged in main direction of flow 18 so that their rough edges 42 are located after or at the same level as a tubular inlet opening 88 in tubular body 85 when viewed in the axial direction.

Prevention elements 40 in this case are connected to instrument gland 7, for example, forming a single unit. However, they [can] **may** also be provided as additional units or only on tubular body 85.

Prevention elements 40 [can] **may**, for example, also be provided in tubular body 85.

The at least one prevention element 40, 79, 82 is connected, for example, to tubular body 85, for example, forming a single unit. Tubular body 85 [has] **includes** a flow channel 87 and a protective screen 90, located in the region of its upstream end, as an element 84 for reducing the impact of fluid or solid particles on measuring element 25.

Protective screen 90 [can] **may** be [designed] **configured**, for example, as a wire mesh or plate-type screen. Any other shape is also possible. Plastic, metal, ceramic or glass [can] **may** be used as the material for protective screen 90, in the case of both the wire mesh and plate-type protective screen 90. Plate-type protective screen 90 made of plastic [can] **may** be produced, for example, entirely by injection molding or by creating screen openings 94 in a plate-type basic body using a material-removal method. Plate-type protective screen 90 made

of metal [can] **may** be produced, for example, from a sheet by punching, eroding, drilling, etc.

A direction of flow 98 exists at a slight distance from protective screen 90 in the downstream region of flow channel 87. Direction of flow 98 [runs] **extends** roughly parallel to main direction of flow 18. Line 14 has **a** center line 21, which, for example, is also the center line of tubular body 85. Measuring unit 4, for example, extends into tubular body 85. A connector end of measuring unit 4 that contains the electrical connections, for example in the form of connector prongs, remains, for example, outside line 14. Measuring element 25, which is in contact with the air flowing through flow channel 87 and is used for detecting [by] air mass entering the internal combustion engine, is provided in a [known] **conventional** manner in measuring unit 4. Measuring element 25 [can] **may** be [designed] **configured** in a [known] **conventional** manner, for example**,** in the form of at least one temperature-dependent resistor. In particular, it is possible to [design] **configure** measuring element 25 as a micromechanical component that has a dielectric diaphragm on which [are provided] resistor elements **are provided**, as [shown] **described**, for example, in German **Published** Patent Application **No.** 43 38 891 [A1] and U.S. Patent No. 5,452,610, respectively. It is also conceivable to incorporate measuring element 25 into line 14 or tubular body 85 without a measuring unit.

At least two braces 101, which hold tubular body 85 in place in line 14, are provided, for example, on tubular body 85. In addition to holding tubular body 85 in place, braces 101 also increase the pressure drop in the air flow between line 14 and

tubular body 85, thus increasing the amount of air flowing through flow channel 87, and braces 101 also straighten the intake air flow in the desired manner.

Tubular body 85 [can] **may** also be provided in line 14 without braces 101, for example**,** it [can] **may** be fastened to measuring unit 4.

Protective screen 90 includes, for example, bars 105 that are positioned perpendicular to each other, for example perpendicular to plug-in axis 10 and horizontal to plug-in axis 10, with bars 105 positioned horizontally relative to center line 21, for example, being arranged at an angle of approximately 30 degrees relative to plug-in axis 10. This varies main direction of flow 18 downstream behind protective screen 90. Protective screen 90 [can] **may** also be oriented at an angle in relation to main direction of flow 18. Dirt particles and fluid droplets are deposited on protective screen 90 and are directed to an inner wall 107 of line 14 or of tubular body 85, thus moving past inlet opening 110 of measuring unit 4 or past measuring element 25.

[Abstract of the Disclosure

] **<u>ABSTRACT</u>**

A device [is described] for measuring at least one parameter, in particular of a volumetric flow, of a medium flowing in a line, in particular of the intake air volumetric flow of an internal combustion engine, [having] **<u>includes</u>** at least one measuring element around which the medium flows. [

According to the related art, constrictions provided in the line and extending into the line in a radial direction produce acoustic disturbances that become noticeable in the form of whistling noises.

]Constrictions [(35, 40, 79) according to the present invention], which do not uniformly constrict the cross-section of the line [(14)], do not produce any ring-shaped eddies that [can] **<u>may</u>** be heard in the form of whistling noises.[

Figure 3a]

DEVICE FOR MEASURING AT LEAST ONE PARAMETER OF A FLOWING MEDIUM

Background Information

The present invention relates to a device for measuring at least one parameter of a medium flowing in a line according to the definition of the species in Claim 1.

A device having a measuring element for measuring a mass of a flowing medium, in which a flow straightener with a screen is provided upstream from the measuring element, is known from German Patent Application 196 52 753 A1. The flow straightener with screen is installed in a rigid conduit inside the line, thereby constricting the line.

A hot-wire air-flow meter, having an orifice that forms a single unit with one wall of the line and is located upstream from the measuring element, is known from German Patent Application 197 38 337 A1 and U.S. Patent No. 5,892,146, respectively. This arrangement constricts the line and increases the flow velocity of a forward mass flow with pulsating flow downstream from, and within the diameter of, the orifice without destroying the flow.

Such ring-shaped constrictions in devices of the publications mentioned above can, under certain flow conditions, produce acoustic disturbances in the line that become noticeable in the form of whistling sounds.

These disturbances are triggered by ring-shaped eddies arising downstream behind one edge of the constriction and propagate in the direction of flow of the line.

A device having a measuring element to measure a mass of a medium flowing in a line, with a flow pipe being located in the line and the measuring element being provided in the flow pipe, is known from German Patent Application 198 156 58 A1. Any loud, disturbing whistling noises that occur are reduced by structural grooves in the end face of the flow pipe.

Advantages of the Invention

The device according to the present invention, having the characterizing feature of Claim 1, has the advantage over the related art that it easily avoids acoustic disturbances, since suppression elements are used to reduce the formation of ring-shaped eddies.

The measures described in the dependent claims provide advantageous embodiments and refinements of the device mentioned in Claim 1.

At least one prevention element is advantageously integrated into a rigid conduit of a flow straightener or into a second rigid conduit to simplify manufacturing.

If there is no flow straightener or rigid conduit, integrating at least one prevention element into one wall of a line advantageously simplifies manufacturing.

According to one advantageous arrangement of the suppression elements, the latter are evenly distributed in the

circumferential direction of the line and have the same shape to avoid distorting the velocity profile of the flow.

At least one suppression element is advantageously designed as an elevation in the line to simplify manufacturing.

One advantageous embodiment of the suppression element provides an orifice with different sections, whose radial spacing varies in relation to a center line of the line.

The prevention elements are advantageously rounded against the main direction of flow to avoid distorting the velocity profile of the flow.

It is particularly advantageous to use a tubular body in the line, thereby avoiding a deviation in the measurement characteristic of a measuring element, caused by the impact of fluid or solid particles.

It is also advantageous to integrate a protective screen into the line or into the tubular body.

Drawing

Exemplary embodiments of the present invention are illustrated in simplified form in the drawing and explained in greater detail in the description below.

Figure 1 shows a device according to the present invention having a flow straightener and a screen, in which at least one prevention element according to the present invention is provided; Figures 2a, 2b show an extract of Figure 1; Figures 3a through 3d show multiple embodiments of suppression

elements; and Figure 4 shows a device according to the present invention with a tubular body.

Description of the Embodiments

Figure 1 shows a partially cut-away view of a device 1 for measuring at least one parameter of a medium flowing in a line 14, in particular a parameter of the intake air mass of an internal combustion engine. Parameters of a flowing medium are, for example, volumetric flow for determining a mass, a temperature, a pressure or a flow velocity, which are detected using suitable sensors. Device 1 can also be used to measure additional parameters.

The flowing medium can be air, a gas mixture or a fluid. The internal combustion engine can be, for example, a mixture-compressing engine with externally-supplied ignition or even an air-compressing engine with spontaneous ignition.

Device 1 includes at least one measuring unit 4, which, for example, can be plugged into an instrument gland 7 of device 1, and in which is provided a measuring element 25. Measuring element 25 can be, for example, a temperature sensor (like the one known from German Patent Application 42 28 484 A1), a pressure sensor (like the one known from German Patent Application 34 35 794 A1), or an air-flow sensor, which detects the corresponding parameters. By way of example, a volumetric air-flow sensor is selected as one of the different possible sensors.

Measuring unit 4 has, for example, a narrow, rod-like, cuboid shape that extends longitudinally in the direction of a plug-in axis 10 and can be introduced, for example by plugging,

into an opening provided in one wall 13 of instrument gland 7. Wall 13 has an inner wall 15 and limits a flow cross-section of line 14, which has, for example, a circular cross-section, in the center of which a center axis 21 extends parallel to wall 13 in direction 18 of the flowing medium and is oriented perpendicular to plug-in axis 10. In Figure 1, the direction of the flowing medium is illustrated by arrows 18 and it moves from left to right.

Measuring element 25 is inserted into the flowing medium together with measuring unit 4. A measuring channel 27, in which measuring element 25 is provided for measuring the medium flowing in instrument gland 7, is incorporated into measuring unit 4 of device 1. The structure of a measuring unit 4 of this type, having a measuring element 25, is sufficiently well known to those skilled in the art, for example, from Unexamined German Patent Application 44 07 209, the description of which forms part of the present patent application.

A screen 32 and a sleeve-like flow straightener 30, which is attached, for example, to a rigid conduit 33, are provided upstream from measuring element 25. Rigid conduit 33 has an inner diameter that is smaller than line 14, thus forming a constriction 35.

Flow straightener 30 is made, for example, of plastic and is produced, for example, by injection molding and has a multiplicity of, for example, rectangular openings 34 oriented in the direction of flow.

The structure of a flow straightener 30 of this type, having screen 32, is sufficiently well known to those skilled in the the

art, for example, from German Patent Application 196 52 753 A1, the description of which forms part of the present patent application. At least one acoustic prevention element 40 is integrally attached, for example, to rigid conduit 33 of flow straightener 30.

For the purpose of final assembly of device 1, the assembly unit formed by flow straightener 30 and screen 32 is inserted into a, for example, circular opening 47 provided at the upstream end of instrument gland 7, until ring-shaped wall 50 of flow straightener 30 comes into contact with a stop 52 of instrument gland 7 that reduces the cross-section of opening 47.

To permanently hold flow straightener 30 in place in opening 47, flow straightener 30 has barbed hook elements 57 on rigid conduit 33, which, for example, extend slightly outward radially from its external surface 55 and can correspondingly latch into place in a groove 60 provided in an inner wall of opening 47 in instrument gland 7.

Figure 2a shows an enlarged extract from Figure 1, identified by a dotted line. Locking hooks 63 are elastic and have locking heads 65 that extend inward in a radial direction. When screen 32 is installed, locking heads 65 grip around an edge of screen 32 like pliers and rest against a surface 68 of screen 32 facing measuring unit 4, so that locking heads 65 press screen 32 against a circumferential shoulder 74 of flow straightener 30 formed by inner surface 70.

A second rigid conduit 72 is located downstream behind rigid conduit 33. Second rigid conduit 72 is provided at the same radial distance from center line 21 as inner surface 70. At

the downstream end of second rigid conduit 72 is provided at least one acoustic prevention element 40, which, for example, forms a single unit and extends into line 14 in a radial direction. Second rigid conduit 72 is pressed against shoulder 52, for example, by rigid conduit 33. However, it can also be fastened in line 14, like rigid conduit 33. Acoustic suppression element 40 acts mechanically on the flow in line 14, thus preventing ring-shaped eddies that form downstream behind an edge of a constriction and propagate in the direction of flow of the line, becoming noticeable in the form of whistling noises.

In a cross-sectional view along main direction of flow 18 through prevention element 40, prevention element 40 has, for example, a rounded shape 41 in the upstream direction and a rough edge 42 in the downstream direction. The at least one suppression element 40 constricts line 14 by 2% to 30%.

Figure 2b shows the design of second rigid conduit 72 and rigid conduit 33 as a single unit. Viewed in the downstream direction, rigid conduit 33 has an extension arm 77 that continues behind screen 32 along inner wall 15. Acoustic prevention element 40, which extends into line 14 in a radial direction, is located at end 78 of extension arm 77. Screen 32 is installed, for example, by bending rigid conduit 33 outward radially in the region of extension arm 77 and then inserting screen 32.

Figures 3a through 3d show different embodiments of prevention element 40. The same reference numbers used in the previous figures identify the same or functionally equivalent components.

Figure 3a shows a prevention element 40 that is designed as a radial elevation 79 relative to center line 21 and has a rectangular cross-section at right angles to main direction of flow 18. Elevations 79, for example, are of the same size and are evenly distributed along a circumferential line 80 of line 14, which is shown by the dotted line.

Radial elevations 79 in Figure 3b have a semicircular cross-section at right angles to main direction of flow 18. Figure 3c shows that radial elevations 79 can have different geometries in one embodiment of the device. In the radial cross-section, they are, for example, trapezoidal or semicircular. Elevations 70 are distributed evenly and arranged symmetrically.

Figure 3d shows a prevention element 40 designed as an orifice 82, whose radial limiting line 81 does not have a constant inner diameter and is designed, for example, in the shape of a wave.

prevention elements 40 in this case form, for example, a single unit with instrument gland 7.

Figure 4 shows device 1 in a line 14 within which a medium flows. The same reference numbers used in the previous figures identify the same or functionally equivalent components. In line 14, and spaced at a radial distance from line 14, is provided, for example, a tubular body 85, around which the medium flows and which serves as an element 84 for reducing the impact of fluid or solid particles on measuring element 25.

Prevention elements 40 are arranged in main direction of flow 18 so that their rough edges 42 are located after or at the same level as a tubular inlet opening 88 in tubular body 85 when viewed in the axial direction.

Prevention elements 40 in this case are connected to instrument gland 7, for example, forming a single unit. However, they can also be provided as additional units or only on tubular body 85.

Prevention elements 40 can, for example, also be provided in tubular body 85.

The at least one prevention element 40, 79, 82 is connected, for example, to tubular body 85, for example, forming a single unit. Tubular body 85 has a flow channel 87 and a protective screen 90, located in the region of its upstream end, as an element 84 for reducing the impact of fluid or solid particles on measuring element 25.

Protective screen 90 can be designed, for example, as a wire mesh or plate-type screen. Any other shape is also possible. Plastic, metal, ceramic or glass can be used as the material for protective screen 90, in the case of both the wire mesh and plate-type protective screen 90. Plate-type protective screen 90 made of plastic can be produced, for example, entirely by injection molding or by creating screen openings 94 in a plate-type basic body using a material-removal method. Plate-type protective screen 90 made of metal can be produced, for example, from a sheet by punching, eroding, drilling, etc.

A direction of flow 98 exists at a slight distance from protective screen 90 in the downstream region of flow channel

87. Direction of flow 98 runs roughly parallel to main direction of flow 18. Line 14 has center line 21, which, for example, is also the center line of tubular body 85. Measuring unit 4, for example, extends into tubular body 85. A connector end of measuring unit 4 that contains the electrical connections, for example in the form of connector prongs, remains, for example, outside line 14. Measuring element 25, which is in contact with the air flowing through flow channel 87 and is used for detecting by air mass entering the internal combustion engine, is provided in a known manner in measuring unit 4. Measuring element 25 can be designed in a known manner, for example in the form of at least one temperature-dependent resistor. In particular, it is possible to design measuring element 25 as a micromechanical component that has a dielectric diaphragm on which are provided resistor elements, as shown, for example, in German Patent Application 43 38 891 A1 and U.S. Patent No. 5,452,610, respectively. It is also conceivable to incorporate measuring element 25 into line 14 or tubular body 85 without a measuring unit.

At least two braces 101, which hold tubular body 85 in place in line 14, are provided, for example, on tubular body 85. In addition to holding tubular body 85 in place, braces 101 also increase the pressure drop in the air flow between line 14 and tubular body 85, thus increasing the amount of air flowing through flow channel 87, and braces 101 also straighten the intake air flow in the desired manner.

Tubular body 85 can also be provided in line 14 without braces 101, for example it can be fastened to measuring unit 4.

Protective screen 90 includes, for example, bars 105 that are positioned perpendicular to each other, for example

perpendicular to plug-in axis 10 and horizontal to plug-in axis 10, with bars 105 positioned horizontally relative to center line 21, for example, being arranged at an angle of approximately 30 degrees relative to plug-in axis 10. This varies main direction of flow 18 downstream behind protective screen 90. Protective screen 90 can also be oriented at an angle in relation to main direction of flow 18. Dirt particles and fluid droplets are deposited on protective screen 90 and are directed to an inner wall 107 of line 14 or of tubular body 85, thus moving past inlet opening 110 of measuring unit 4 or past measuring element 25.